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A NEW EASTERN PACIFIC WORMFISH, *MICRODESMUS KNAPPI* (PISCES:MICRODESMIDAE)

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There are 16 recognized species of wormfishes described from low temperate and tropical waters of the Western Hemisphere. One of these, *Microdesmus lanceolatus* Dawson, is known only from the holotype dredged at a depth of 37 meters (m) but the remainder most commonly occur in estuarine, coral reef and tidepool habitats at depths of less than 3 m. The majority of estuarine forms burrow in sand and mud substrates of low energy beaches and mangrove swamps. I here describe an unusual new estuarine species from a beachrock habitat on the Pacific coast of Colombia.

Reported specimens, obtained through personal collections and the Smithsonian Oceanographic Sorting Center (SOSC), have been deposited in the following institutions: Academy of Natural Sciences of Philadelphia (ANSP); California Academy of Sciences (CAS); Gulf Coast Research Laboratory Museum (GCRL); School of Marine and Atmospheric Sciences, University of Miami (UMML); National Museum of Natural History, Smithsonian Institution (USNM). Head length is measured from tip of lower jaw to articular base of the dorsalmost pectoral fin-ray, eye diameter is that of the pigmented area only, body depth is measured at anal fin origin, caudal fin length is the distance between posterior margin of hypural vertebra and tip of longest caudal ray. Measurements, taken with needlepoint dial caliper or ocular micrometer, are in millimeters (mm); proportions are shown as percentages of stan-

dard length (SL) or head length (HL); all fin-rays are counted separately.

Appreciation is expressed to Dr. Constantine Tapias for expediting my work in Colombia and to Srs. O. Arroyo, O. Barona, and M. Estevez for assistance in the field. I thank Dr. R. R. Priddy, Millsaps College, for prompt examination of a beachrock sample from the type-locality and Dr. V. G. Springer (USNM) for critical review of the manuscript. Drawings are by Harry L. Moore, Jr. This study was supported in part by National Science Foundation Grant GB-15295.

Microdesmus knappi new species

Figure 1

Holotype: USNM 206506 (54.5 mm SL); Colombia, Valle del Cauca, Bahia de Buenaventura, off Punta la Guida, approx. 03°51′00″N, 77°10′00″W (H. O. Chart 1786); ichthyocide; 8 Oct. 1969; Sta. No. LK 69–42; L. W. Knapp.

Paratypes: USNM 206507 (1, 58.9 mm SL), GCRL 7816 (1, 56.4 mm SL, cleared, stained, and partly dissected); Bahia de Buenaventura, rocky point S of La Bocana, approx. 03°50′51″N, 77°09′55″W; 0–0.6 m; ichthyocide; 1 Nov. 1970; Sta. No. LK 70–19; L. K. Knapp, W. R. Taylor and M. Estevez. ANSP 117497 (1, 52.6 mm SL), CAS 13979 (1, 49.7 mm SL), GCRL 7817 (4, 52.4–61.0 mm SL), UMML 29864 (1, 51.6 mm SL), USNM 206508 (1, 49.9 mm SL); Bahia de Buenaventura, Punta la Guida, approx. 03°50′54″N, 77°10′00″W; from holes in beachrock; ichthyocide; 20 Nov. 1971; C. E. Dawson, O. Arroyo and M. Estevez.

Diagnosis: Pectoral rays 11; anal fin-rays 23–25; head breadth 57–64 percent of head length, broadly rounded in front; eye obscured, lacking a distinct orbital margin; lips fleshy, plicate, united to form a prominent, free dermal flap at angle of gape; teeth uniserial, incisiform; scales inconspicuous, well separated, sparse on head; body and head finely freckled, without distinct stripes, bars or blotches; proximal pterygiophore of 1st dorsal spine usually inserted between 4th and 5th neural spines; abdominal vertebrae more numerous than caudal vertebrae.

Description: Dorsal fin XVI–XVIII, 28–30, total dorsal fin elements 45–47; anal fin 23–25; pectoral fin 11; pelvic fin I, 3; segmented caudal fin-rays 17; vertebrae $27 - 28 + 20 - 21 = 47 - 48$. See Tables 1 and 2 for proportional measurements and counts.

Body moderately elongate, depth at anal fin origin averages about 8 percent of SL, tapers little posteriad but narrows to about 6 percent of SL at caudal peduncle; slender, breadth at anal fin origin about 38

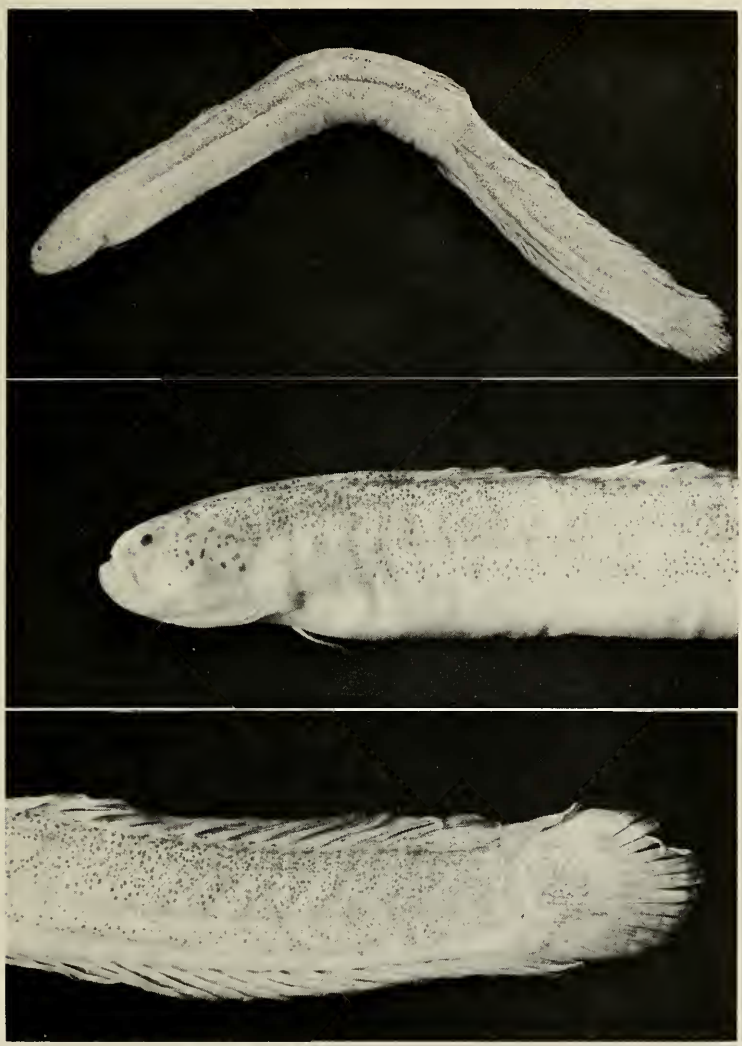


FIG. 1. *Microdesmus knappi* USNM 206506; holotype; 54.5 mm SL.

percent of HL, greatest breadth (about 64 percent of HL in holotype) at opercles; caudal fin short, broadly rounded, greatest depth about 20 percent greater than body depth, united to posteriormost dorsal and anal fin-rays, without a well-defined peduncle; holotype with 15 branched caudal rays and a simple segmented ray above and below, cleared para-

Table 1. Measurements of *Microdesmus knappi* in millimeters (mm) and in percent of standard length (SL) or head length (HL).

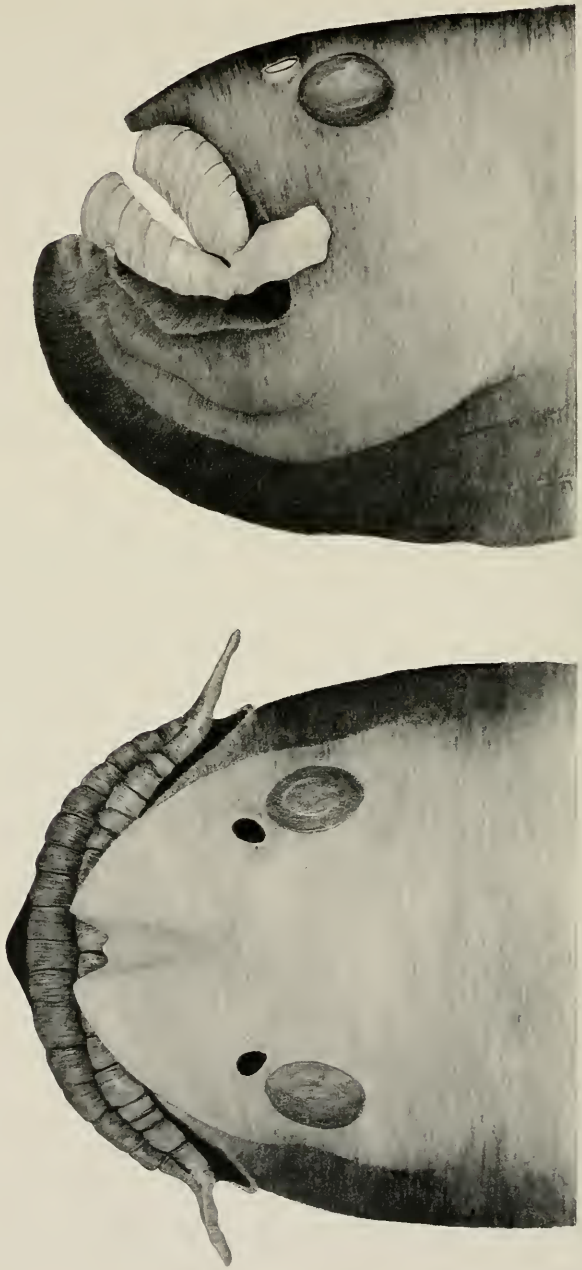
	Holotype (mm) USNM 206506	Paratypes (mm)			Percent SL or HL*		
		N	Range	$\bar{x}$	N	Range	$\bar{x}$
Standard length	54.5	10	49.7–61.0	54.7			
Caudal fin length	4.6	9	4.1– 5.0	4.6	10	8.0– 9.0	8.4
Least caudal peduncle depth	3.1	10	2.8– 3.5	3.2	11	5.3– 6.4	5.8
Depth at anal fin origin	4.0	10	3.7– 4.7	4.2	11	6.4– 8.5	7.6
Predorsal length (to tip of lower jaw)	8.7	10	7.7–10.0	8.6	11	14.4–17.7	15.8
Preanal length	33.7	10	32.7–39.0	35.5	11	61.8–66.2	64.7
Pectoral fin length	2.6	9	2.4– 3.1	2.8	10	4.2– 5.6	4.9
Pelvic fin length	1.8	10	1.6– 2.1	1.8	11	2.7– 3.8	3.2
Pelvic insertion to anal fin origin	28.6	10	27.0–33.3	30.0	11	52.4–56.8	54.6
Head length	5.2	9	5.0– 5.6	5.3	10	8.9–10.4	9.7
Eye diameter*	0.4	9	0.4– 0.5	0.4	10	7.1–10.0	8.0
Preorbital length*	0.8	8	0.9– 1.1	1.0	9	15.3–20.0	18.1
Anterior margin of eye to tip of lower jaw*	1.2	9	1.3– 1.7	1.5	10	23.0–30.3	27.5
Postorbital length*	3.6	9	3.1– 3.6	3.4	10	60.7–69.2	64.5
Interorbital width*	0.8	9	0.7– 1.0	0.8	10	13.4–17.8	15.5
Head breadth*	3.0	10	3.1– 3.6	3.3	10	57.6–64.2	60.7
Tip of lower jaw to posterior angle of gape*	1.1	8	0.8– 1.5	1.2	9	15.0–26.7	21.3

TABLE 2. Meristic data from holotype and paratypes of *Microdesmus knappi.*

	Holotype USNM 206506	Paratypes		
		N	Range	Mode
No. of dorsal spines	17	10	16–18	17
No. of dorsal segmented rays	30	10	28–30	29
Total dorsal fin elements	47	10	45–47	46
No. of anal fin-rays	25	10	23–25	25
No. of pectoral fin-rays	11 (2)	16		11
No. of abdominal vertebrae*	27	10	27–28	27
No. of caudal vertebrae	21	10	20–21	20
Total vertebrae	48	10	47–48	48
Anal fin origin beneath interspace between dorsal fin elements	25/26	10	24/25–25/26	

* Vertebral counts from radiographs.

type similar but 4 simple procurrent elements are visible above and below the segmented rays. Predorsum curves slightly ventrad toward head, length averages about 16 percent of SL; predorsum broad and more or less flat, with a distinct median longitudinal depression from dorsal fin origin to nape. Head length about 10 percent of SL; head broad, not distinctly narrowed in front, depth somewhat less than body depth; interorbital slightly convex, its width more than twice eye diameter; posterior naris dorsolateral, diameter contained about three times in eye, located in a short fleshy tubule less than one narial diameter removed from anterodorsal margin of eye; anterior nares, about ⅓ diameter of posterior, open anteroventrad at tips of distinct, fleshy, tubiform prominences that overhang upper lip (Fig. 2); snout depressed ventrad between narial ridges, the anteromedian profile variously V-shaped as viewed from above, frequently with a minute fleshy lobe on midline. Lips prominent, fleshy, plicate, continuous across symphyses, lower lip slightly emarginate beneath anterior nares; lips united laterally, forming a free dermal flap (0.5 mm long × 0.3 mm wide in holotype) which, in undamaged preserved material, extends outward at about 45° from angle of gape; a distinct groove, concealed by swollen lips, extends from base of anterior narial prominence around angle of gape and along side of lower jaw to near vertical from tip of overhanging narial tube; gape short, its posterior angle (beneath lips and dermal flap) fails to reach vertical from anterior margin of eye, most frequently falls short of vertical from posterior naris. Eye small, dorsolateral, distinguishable only as a dark pigmented area through the skin, without an obvious iris and lacking a definite orbital margin. Teeth uniserial, strong and incisiform in cleared and stained paratype (Fig. 3); 10 slightly recurved teeth on dentary, posteriormost 3 about half as long as anterior teeth; premaxilla



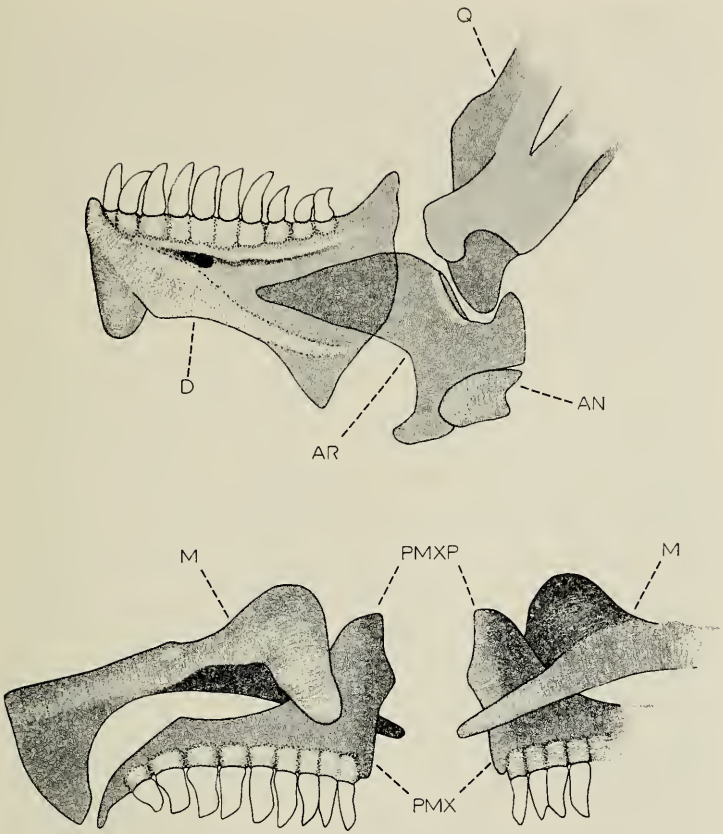


FIG. 3. (Top). Lateral view of lower jaw of *Microdesmus knappi*. (Bottom). Maxilla and premaxilla; inner aspect (left), outer (right). AN: retroarticular; AR: articular; D: dentary; M: maxilla; PMX: premaxilla; PMXP: premaxillary pedicel; Q: quadrate.

with 2 relatively straight, slender teeth anteriad, and with 7 somewhat recurved, broader teeth behind, the last 4 of which gradually shorten posteriad; tongue broadly rounded. Gill opening restricted, distance between upper and lower points of origin less than width of pectoral fin

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FIG. 2. Semidiagrammatic delineation of anterior head of *Microdesmus knappi*; lateral aspect above, dorsal below. Anterior naris opens at tip of narial prominence overhanging upper lip.

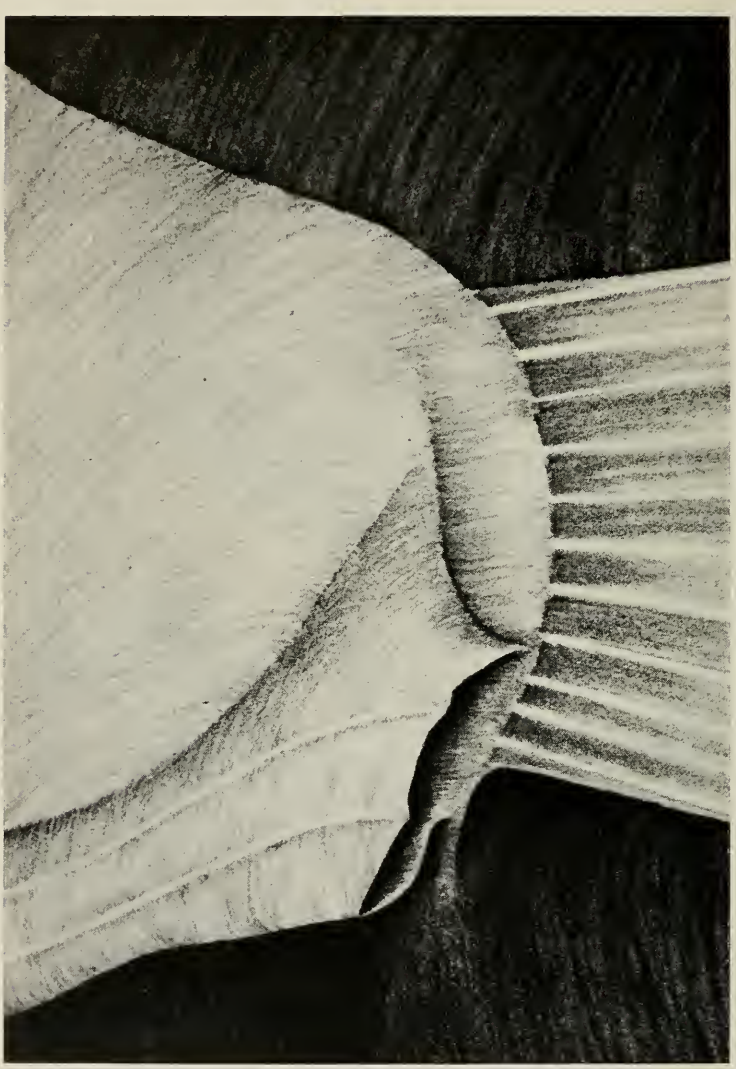

FIG. 4. Left gill opening of holotype of *Microdesmus knappi*. Upper point of origin near base of 4th (counting dorsad) pectoral ray; lower point of origin on pectoral fin base and below lowermost pectoral fin-ray.

base, not continued to isthmus, variable both bilaterally and between individuals; bilateral morphology of holotype, one paratype and right and left sides, respectively, of two other paratypes as illustrated (Fig. 4); gill openings somewhat more tubiform in remainder of type series; gill opening extremes range from upper and lower points of origin approximated near base of 3rd (counting dorsad) pectoral fin-ray, to where lower point is well removed and united somewhat posteriad to a narrow dermal expansion along anteroventral margin of pectoral fin.

Dorsal spines flexible, equally spaced; 1st spine averages about 30 percent shorter than 4th, 2nd and 3rd successively longer than 1st, remaining dorsal fin elements of more or less equal length; all dorsal fin elements bound by a continuous membrane; dorsal fin originates ⅓ to ⅔ of pectoral fin length behind vertical from tip of adpressed pectoral fin; 1st segmented dorsal ray branched in all specimens; anal fin height about 20 percent less than that of dorsal at vertical from 5th anal fin-ray, 1st and 2nd anal rays about 20 percent shorter than remainder; 1st anal ray branched in holotype and three paratypes, apparently simple in other specimens; terminal dorsal and anal fin-rays typically included within dermal envelope of caudal fin, usually without a distinctly separate membranous connection to caudal fin; terminal rays difficult to see without transmitted light, easily overlooked; last dorsal fin-ray branched, last anal ray simple in cleared specimen. Pectoral fin narrowly rounded, 6th–8th rays (counting ventrad) longest, uppermost and lowermost minute; holotype with 3 simple rays above, 7 branched rays and simple ray below; pelvic fins separate, with minute outer spine and 3 simple segmented rays, innermost ray about 38 percent longer than 2nd ray and 58 percent longer than outermost. Scales embedded, separated, most closely spaced, but seldom touching, along myomeric impressions; maximum observed scale diameter in cleared paratype 0.2 mm, about 14 scales fall on vertical between anal fin origin and dorsal fin base; a few scales present on cheek, opercle and between nape and interorbital, 1 or 2 scales just before pelvic fin insertion, remainder of head and chest apparently naked; scales most abundant on upper sides and predorsum (to nape), smaller and more widely spaced ventrad, midventral surface of abdomen apparently naked; caudal fin with 2 or 3 irregular scale rows proximad, other fins and pectoral fin base naked.

Usually 1 well-ossified predorsal interneural between 3rd and 4th neural spines and first proximal pterygiophore inserted between 4th and 5th; 2 paratypes (CCRL 7816; CCRL 7817, 57.8 mm) have 2 predorsal interneurals with the 1st proximal pterygiophore inserted between the 5th and 6th neural spines; distal pterygiophores begin immediately behind 1st segmented dorsal ray and behind 2nd anal fin-ray; ossified frontals fail to reach mesethmoid and lateral ethmoid; suspensorium, jaws and cranium well ossified; basihyal very short, broadly triangular, slightly emarginate in front; abdominal neural spines strong, rather broad, often distally truncate, usually shorter than centrum length; pre-

zygopophyses low, not distinctly elevated; pleural ribs articulate with centra of 1st and 2nd vertebrae, subsequently articulate with parapophyses; epipleurals begin at 3rd vertebra. Last dorsal and anal fin elements lack pterygiophores, their bases are approximated to that of the respective penultimate ray; last dorsal proximal pterygiophore inserted between neural spines of 5th and 6th pre-ural centra, terminal anal proximal pterygiophore is between the 4th and 5th.

Ground color in alcohol pale tan; without dark bars, stripes or prominent blotches. Upper body of holotype shaded with a dense scattering of dark tan to brown melanophores, which gradually disperse and vanish ventrad; venter and narrow band above anal fin immaculate (Fig. 1); top of head to interorbital, cheeks and opercles above line from angle of gape to upper pectoral angle with scattered melanophores that become sparse ventrad; a few melanophores on outer surface of narial prominences but interorbital and remainder of snout immaculate; lips and oral flaps pale, a small patch of melanophores on tip of lower jaw, eye black, remainder of head immaculate; dorsal fin mainly pale with a few tan melanophores along some fin-rays; caudal fin base densely speckled with brown, tan streaks line most segmented rays, distal margin pale; remaining fins immaculate. Peritoneum (one specimen examined) pale ventrally, speckled with jet black melanophores above.

Aside from minor variations in melanophore density or shade of brown, preserved coloration is similar in all paratypes. Life coloration of specimens from LK 70–19 was recorded by Dr. Knapp as "reddish-brown color like that of earthworms"; all of my specimens were bright pink to red and finely speckled with darker points in areas now occupied by brownish melanophores.

Branched dorsal and anal fin-rays, the expected adult complement of 15 branched caudal rays, and evidence of developing gonads in some specimens indicate that the type-specimens are adult or near adult fish.

Etymology: I name this species for the collector of the holotype, Dr. Leslie W. Knapp, in recognition of his diligence and expertise in the field and in acknowledgment for many valuable specimens and personal courtesies provided.

Comparisons: Although distinguished from all known wormfishes by having the least number of anal fin-rays and caudal vertebrae, free oral flaps, and uniserial dentition, *Microdesmus knappi* exhibits similarities in one or more characters with a number of species or species groups. *Clarkichthys bilineatus* (Clark) shares the modal count of 11 pectoral rays, but its boldly striped coloration, biserial dentition, 28–31 anal rays, and differences in head and dorsal fin morphology preclude confusion with *Microdesmus knappi*. The relatively short body, broadly rounded caudal fin, and frequently tubiform gill openings are suggestive of *Cerdale ionthas* Jordan and Gilbert, which may have as few as 27 anal fin-rays and 22 caudal vertebrae. *Cerdale*, however, has more caudal than abdominal vertebrae and differs in gross morphology, dentition,

TABLE 3. Range of vertebral counts in species of *Microdesmus* with more abdominal than caudal vertebrae.

	N	Abdominal vertebrae	Caudal vertebrae	Total vertebrae
M. carri	160	36–39	29–34	66–71
M. suttkusi	50	35–37	30–32	66–69
M. retropinnis	70	31–33	26–29	57–61
M. knappi	11	27–28	20–21	47–48

squamation, and in having modal counts of 14 pectoral rays (Dawson, Ms.).

There are four microdesmids with more caudal than abdominal vertebrae (Table 3). Number of abdominal vertebrae is a conservative character in wormfishes, the typical range of three centra being exceeded in only one fish among several hundred specimens examined, and these four species represent a distinctive group within the catchall genus *Microdesmus*. Reid's (1936) treatment of Atlantic and eastern Pacific wormfishes as an open-ended continuum is inadequate and not in accord with evidence now at hand. This matter will be more fully treated in a subsequent report, but certain intra-group comparisons are warranted here.

The recently described geminate species *M. carri* and *M. suttkusi* (Gilbert, 1966) are slender, elongate forms with 11–14 pectoral rays, relatively large and unrestricted gill openings and dentition triserial in part. They are most readily separated from *M. knappi* by their total dorsal fin-ray counts of 66–72. *Microdesmus retropinnis* Jordan and Gilbert has partly triserial dentition and slender form, but its pectoral rays are modally 10 and the gill openings, though somewhat variable, are always more restricted than those of *carri* and *suttkusi* and generally similar to that illustrated for *M. knappi*. Numbers of dorsal spines and total dorsal fin elements overlap those of *knappi*, but *M. retropinnis* is marked with distinctive bars and stripes, and the anal fin, which originates beneath the 16th–22nd dorsal fin elements, has 28–32 rays.

Habitat: The holotype and paratypes taken by Dr. Knapp were swimming at the surface. He had the distinct impression that these fish came from a beachrock area, about a meter distant from the actual point of collection, rather than from the immediately surrounding sandy-mud and boulder bottom. I visited the same area on a falling tide in late 1971 and was able to confirm Knapp's impressions and determine the apparent micro-habitat of *M. knappi*. I initially poisoned open water flushing the base of high beachrock at Punta la Guida as well as several shallow rock and sand tidepools on the gently sloping beach immediately east of the point; salinity and temperature of open surface water were 15.0 ‰ and 29.5 °C. One *Cerdale ionthas* and about 40 *Microdesmus retropinnis* were obtained, but no *M. knappi* were seen during about 2

FIG. 5. Beachrock habitat of *Microdesmus knappi* during collection of paratypes on low incoming tide, 20 Nov. 1971. All specimens taken at waist to shoulder heights and from holes in rock face (Srs. M. Estevez, left, and O. Arroyo).

hours of intensive search. Shortly after low tide, I poured poison directly on the beachrock, some 2 meters above its base, and the poison was allowed to flow slowly down the almost vertical face of the beachrock. Soon, the first *M. knappi* was seen trying to escape from one of the many small holes and canals riddling the eroded rock, and eight specimens were collected within 30 minutes. All were taken at waist to shoulder heights above the rock base, and well above existing tide level (Fig. 5). Specimens were taken with considerable difficulty as they squirmed through interconnecting canals in the rock, and it was often necessary to break off pieces of the soft rock in order to secure a particular fish. The only other organisms taken from the canals were two small stomatopods (identified as *Gonodactylus festai* Nobili by Dr. R. B. Manning, USNM) and one *Microdesmus retropinnis*. The beachrock formation extends more than 30 m along the Punta la Guida shore, but collecting efforts were restricted to less than a fifth of this distance.

Dr. R. R. Priddy examined a sample of the beachrock and information from his report is abstracted as follows: a dark gray marine or brackish-water sandstone composed of poorly and incompletely cemented, well sorted, fine quartz sand; cementing material is 90 percent clay and 10 percent limonite; riddled with sub-rounded, unoriented, sinuous holes 50–250 mm deep and 20–150 mm across; burrowing animals honey-

combed the deposit before lithification and the mucous lining and filling of holes was removed as modern waves eroded the exposed beachrock. I have no information on the extent or frequency of this type of formation in western Colombian waters, but I have not seen similar sedimentary facies during several years of Pacific shore collecting from México to Panamá.

Frayed caudal and pectoral fins in several fish and occasional unilateral loss of an oral flap, possibly resulting from abrasion, suggests that *M. knappi* is a more or less permanent resident of the beachrock habitat. Apparent absence of this species from nearby, but entirely different environments, during 1971 collecting provides supporting evidence for this conclusion. Mean tide range at Buenaventura is 3.12 m (U.S. Dept. Commerce, 1970) and beachrock levels occupied by *M. knappi* are without active water exchange during several hours of each tide cycle. These fish evidently survive in the small quantity of water retained within the rock, and intriguing eco-physiological problems dealing with temperature variation and rapid salinity changes accompanying not infrequent rainstorms remain to be investigated.

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